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AGGREGATES

Their Influence on the Fire Resistance of Concrete

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The subject of fire resistance of concrete is one of vital interest, considering the fact that many structures built of concrete are exposed to fire hazard. Several phases of this subject could profitably be discussed, but since the coarse aggregate plays a major role in the resistance of concrete against intense heat this phase alone will be considered at this time.

Many special tests have been performed to determine the relative fire resistance of concretes containing different coarse aggregates and there are numerous examples of fire effects in actual structures. The subject has been well investigated and the results of the tests in general substantiate the results of fires on structures and they point very definitely in the same direction.

An independent search through the literature on fire resistance would be a big undertaking but fortunately this has already been done by Committee E-4 on Fire Resistance of Concrete of the American Concrete Institute. The salient features of this report as it pertains to aggregates are presented herewith with direct quotations from the report as published in the 1925 Proceedings of the American Concrete Institute.

"Probably the most valuable contribution to the study of the effects of fire on concretes in which the various aggregates are used was the series of tests of the special commission formed by the British Fire Prevention Committee. And next in importance the tests of the Bureau of Standards at Pittsburgh and those at the Underwriters Laboratories in Chicago made jointly by the Underwriters Laboratories, The Factory Mutual Insurance companies and the Bureau of Standards. These tests gave results which correspond with the conclusions drawn from Prof. Woolson's tests which were reported to the American Society for Testing Materials in 1905, 1906 and 1907 and will be reviewed very briefly. * * * * *"

Tests of Concrete by the British Fire Prevention Committee

The primary object of this series of tests, the most comprehensive thus far undertaken, was to study the effect of fire on concrete made with different aggregates.

"Ninety-two plain concrete slabs 10 ft. 8 in. long by 3 ft. 6 in. wide and 5½ in. thick, exposing 10 ft. by 2 ft. 9 in. of the soffit, were fire tested, while under superimposed loads. Of these 49 had natural aggregates, the others artificial aggregates. The natural aggregates included six kinds of gravel from seven sources, seven kinds of sandstone, four limestones, and eleven igneous rocks, five of which were commonly classed as granites. The artificial aggregates included five kinds of brick, a burnt clay, blast-furnace slag from two sources, coke breeze and pan breeze from two sources each and clinkers from three (two from bituminous coals, one from anthracite).

"The 67 slabs of reinforced concrete were 11 ft. 6 in. square with exposed soffits 10 ft. square. The two-way reinforcement of ⅜-in. plain round rods, alternately of lengths 11 ft. 3 in. and 9 ft. 3 in., with fish-tailed ends, was placed in various slabs at ½ in., 1 in., 1½ in., and 2 in. from the bottom of the slabs. * * * * * * * *"

"The fire test period for 44 of the plain concrete slabs was three hours followed by a two-minute application of water from a ⅝-in. nozzle (pressure nearly 50 lb. per square inch). Twelve were similarly exposed to fire without the subsequent application of water. The superimposed loads were 224 lb. per square foot. Twenty-two slabs were loaded to 280 lb. per square foot and subjected to four hours' fire and five minutes' application of water. Fourteen other slabs had protective coatings of plaster and (or) concrete applied to the soffit. Most of the slabs were of 1:2:4 mix; there were, however, several in which richer mixes were used and in some instances fine aggregates other than sand were employed.

"The gravels, sandstones, granites and other highly

siliceous aggregates were unsatisfactory, while the fine-grained igneous rocks, classed as basalt, dolerite and trachyte gave satisfactory results. The limestones were better than the siliceous aggregates, the fine-grained stone being distinctly better than the coarse-grained.

"Coarse aggregates of clean broken bricks and burnt clays gave the most satisfactory results from strength and resistance to fire. Blast-furnace slag appeared to be almost as good. Pan breeze and clinker were fairly satisfactory as aggregates for plain concrete slabs. In some cases coke breeze used as fine aggregate gave better results than sand in comparable slabs.

"Not all aggregates suitable for plain concrete slabs give good results in reinforced concrete, usually, however, aggregates which are unsuited for one are not suitable for the other. This has proven to be the case with the gravels, sandstones, and the coarse-grained and highly siliceous rocks. Those aggregates which gave the best results in plain concrete have proven to be the most satisfactory ones in the reinforced-concrete slabs. Pan breeze and coke breeze which fairly gave satisfactory results in plain concrete slabs did not give satisfactory results in the reinforced slabs.

ing gave satisfactory results with a plain slab. One-half inch of gravel concrete plus 1 in. protective coatings of fine coke or pan breeze mortars as protection to the steel in reinforced-concrete slabs was not sufficient.

"In parallel with the tests of plain and reinforced-concrete slabs the heat conductivity of the various concretes was measured. In 22 of 30 tests the temperature at 1 in. from the soffit was 1,200 deg. F. or higher at four hours. The coarse aggregates in the slabs which did not attain to 1,200 deg. F. were slag, limestone (2), basalt, andesite, coke breeze, broken brick and dolerite (whinstone). The highest temperatures at points near the top of the slabs were attained with concretes having as coarse aggregates siliceous gravel (2), cal careous gravel, coke breeze and quartzite."

Column Tests at the Pittsburgh Laboratories of the Bureau of Standards

These tests were designed to secure information as to the effects of kind of aggregate, the type of reinforcement and the shape of cross-section on the fire resistance and strength of the column at high temperatures. Sixty-two columns were subjected to fire tests while under

RESULTS OF CONDUCTIVITY TESTS BY THE BRITISH FIRE PREVENTION COMMITTEE.

	Number of Samples Tested	Kind of Coarse Aggregate	Kind of Fine Aggregate	Mix	Order of Merit for 1-in. Protection*	Order of Merit for 2-in. Protection**
Natural Aggregates	5	Limestone	Sand	1:2:4	100	100
	4	Whinstone Traprock	Sand	1:2:4	89	95
	2	Basalt	Sand	1:2:4	84	99
	6	Sandstone	Sand	1:2:4	83	96
	3	Granite	Sand	1:2:4	69	90
	2	Irish Pit Pebble	Sand	1:2:4	67	66
	3	Gravel	Sand	1:2:4	66	87
Artificial Aggregates	1	Pan Breeze	Fine Pan Breeze	1:2:4	91	88
	2	Burnt Gault Clay	Sand	1:2:4	88	121
	3	Slag	Sand	1:2:4	81	81
	2	None	Fine Coke Breeze	1:5	78	108
	4	Brick	Sand	1:2:4	73	96
	3	Coke Breeze	Sand	1:2:4	72	82
	3	Clinker	Sand	1:2:4	61	86
	1	Coke Breeze	Fine Coke Breeze	1:2:4	29	53

* Based on the time required for concrete to attain 1000 deg. F. at one inch from soffit of slab.
** Based on the relative temperatures attained at the end of 4 hours. In each case limestone concrete considered as 100 as an arbitrary point on the scale.

"Siliceous gravel in equal proportions with basalt for the coarse aggregate in 1:2:4 mixtures did not give satisfactory results in either plain or reinforced concrete. Nor were the siliceous gravel concretes with 1-in. protective coatings of coke breeze, pan breeze or broken brick concretes on the soffit satisfactory in either the plain or reinforced slabs, except in the case of thoroughly dried, year-old slabs. One case of 2-in. protective coat-

normal working loads.

"The tests gave widely different results due mainly to the differences in the mineral composition of the aggregates. Aggregates with high quartz, chert or granite content are likely to induce spalling or serious cracking of the concrete when subjected to fire of moderate intensity and duration. On the other hand, concretes made with calcareous aggregates, such as limestone or calcareous gravel, suffer few visible effects

even when exposed to very severe fires of four hours' duration. Concretes made with trap rock or blast-furnace slag give results intermediate between these.

"The poor showing of the concrete columns made with siliceous aggregates when subjected to fire is due mainly to the expansion characteristic of quartz and other forms of silica and minerals containing them. They spalled and cracked very badly, exposing the reinforcement in most cases to the high temperatures of the furnace. Increasing the thickness of the covering to 2½ in. did not give suitable protection.

"* * * * * * * * * * Columns made with concrete having limestone or calcareous gravel aggregates made quite the best showing of all columns having concrete protection. They did not crack or spall extensively, nor did the dehydration of the concrete reach to as great a depth. The limestone near the surface was calcined. Concretes made with these aggregates had better heat insulating qualities than the others.

"Such columns with the proper amount of vertical and lateral reinforcement protected by 1½ in. of concrete outside of the steel resist test fires comparable to the most severe fire conditions that may reasonably be expected with almost any building occupancy. * * * * * * *"

Tests at the Underwriters Laboratory, Chicago

Fire tests were made on 106 columns and the following are some of the significant results obtained:

"The mineral composition of the aggregates had the most influence on the fire-resistive properties of the concrete. Not only were some of the concretes distinctly better than others but showed greater recovery of strength after exposure to fire.

"With regard to the variations of the fire resistance of the concretes with respect to difference in aggregates used, it might be well to quote from Technologic Paper No. 184, p. 179, 'With a given thickness or size of covering the main cause of variation in results was the difference in the fire resisting properties of concrete made with different aggregates.

"'In this particular the concrete can be placed in three groups. That giving the most unfavorable results was the concrete made with the Meramec River sand and gravel, a number of large cracks forming early in the tests followed by spalling of large and small pieces of concrete not held by the ties. This sand and gravel consists almost wholly of quartz and chert grains and pebbles, the gravel having a particularly high chert content. Both minerals are forms of silica (SiO_2) the quartz being crystalline and anhydrous, and the chert amorphous, with a variable amount of water in chemical combination. On being heated part of the combined water in chert is liberated, and the consequent vaporization disrupts the pebbles. Other causes of disruption of concrete made with siliceous aggregates are abrupt volume changes, points of which are known to exist for chert as low as 210 deg. C. (410 deg. F.) Quartz has a decided point of abrupt volume change at 573 deg. C. (1063 deg. F.), where it is transformed into Beta quartz and later into the mineral tridymite, the change extending over a considerable temperature range when the heating is rapid. Liquid inclusions contained in small cavities formed when the rock crystallized from the molten condition, may be the cause of some of the cracking incident with fire exposure.

"'The middle group includes concrete made with trap rock, granite, sandstone, and hard coal cinder. In tests with trap rock and cinder concrete a small amount of cracking developed during the last part of the fire period, but no spalling of note occurred before failure. In the granite concrete protections cracking and spalling of the corners outside of the wire ties began in the first 30-min. period and continued during the next hour, after which there was little apparent change before failure. The spalling exposed portions of the flange edges, which to some extent hastened the failure. The average time to failure in tests with sandstone-concrete protections was intermediate between those with trap rock and those with cinder concrete. The cracking of sandstone concrete after a short fire exposure can be ascribed mainly to the abrupt volume change of the constituent quartz grains as noted above.

"'Fusion of the trap rock concrete occurred where the tests extended beyond 7 hours, the concrete being affected to a depth of about 1½ in. Flowing of concrete due to fusion, while not general, occasionally formed pockets up to a 2-in. depth. Incipient fusion to about the same depth occurred in the 4-in. granite-concrete protections, although no actual flowing of concrete took place.

"'The third group comprises protections of Chicago-limestone concrete and Joliet-gravel concrete. The composition of this gravel is similar to that of Chicago limestone, and the fire resisting properties of the concrete made with each compare quite closely. Very little cracking resulted on exposure to fire and their heat-insulating value was increased by the change of the calcium and magnesium carbonates to the corresponding oxides. This process retarded the flow of heat through the region of change and left material of good insulating properties. Immediately after the test the surface of the concrete was firm, but after a few weeks' exposure the hydration of the oxides caused slaking and crumbling of the calcined material. * * * * * * * *'

"The features of greatest interest in connection with the tests are the useful limits of the protective coverings when subjected to fire and the value of the column afterwards. Ratings in fire resistance made after all phases of the tests had been carefully considered are given in the following table:

FIRE RESISTANCE PERIODS DERIVED FROM THE TEST RESULTS

Type of Column	PROTECTION		Minimum Area of solid Materials sq. in.	Nominal Thickness of Protection in.	Fire Resistance Period hrs.
	Material	Details			
Structural Steel	Concrete: sil. Gravel aggregate	Mixture 1:6 tied with steel ties or wire mesh equivalent to not less than No. 5 (B&S) wire on 8-in. pitch.	100	2	1
Structural Steel	do	do	200	4	2½
Structural Steel	Concrete: granite sandstone or hard coal cinder aggregate.	Mixture 1:6 concrete tied as above	100	3	2½
Structural Steel	do	do	140	3	3½
Structural Steel	do	do	200	4	5
Structural Steel	Concrete: traprock aggregate.	Mixture 1:6 tied as above	100	2	3
Structural Steel	do	do	140	3	4
Structural Steel	do	do	200	4	5
Structural Steel	Concrete: limestone or calcareous gravel aggregate.	Mixture 1:6 Concrete tied as above	100	2	4
Structural Steel	do	do	140	3	
Structural Steel	do	do	200	4	8
Reinforced Conc.	Limestone or calcareous gravel concrete	Mixture 1:6 Concrete reinforced with vertical bars and lateral ties or hooping	220	2	8
Reinforced Conc.	Trap rock concrete	do	220	2	5

"In the fire and water tests of reinforced-concrete columns the 1-hour fire affected the limestone and trap rock concretes very little, while the siliceous gravel concrete cracked and spalled, exposing portions of the reinforcement in the spirally hooped column. * * * * * * * *"

Résumé

"The lessons that may be drawn from the studies so far made by the committee are that the fire resistance of concretes depends to a great extent on the kinds of aggregates used. Aggregates, such as the siliceous gravels used in the tests reviewed, result in concretes which are likely to spall rather quickly when exposed to fires. Small percentages of chert or other highly siliceous aggregates mixed with aggregates which do not spall may still cause serious cracking and spalling. Sandstones and granites vary somewhat in affecting the fire resistance of concrete in which they are used as aggregates, but usually the results are slightly better than with the siliceous gravels. Both have the tendency to crack and spall. Hard-coal-cinder concrete does not show this tendency but transmits heat more readily, therefore, does not give longer protection to the steel and structural concrete. Concrete made from blast furnace slag gives results in fire tests about equal to those of trap rock concrete. Both are decidedly better than concretes having the highly siliceous aggregates. In nearly all tests limestone has been shown to be superior to all the other natural aggregates in its fire resisting qualities. There is little or no tendency for the limestone concrete to spall or crack and its insulating value is generally greater. In fires of long duration the limestone aggregate near the surface becomes calcined and in some cases necessitates more surface repair to the protective covering than where trap rock is used, but these cases are the exception rather than the rule. So far as tests have been made it has been found that for rocks of a given mineral composition those of coarsely crystalline structure are not as resistant to fire as those of fine structure. Broken bricks or burnt clay aggregates give favorable results in strength and fire resistive properties."

The President's Page

In Memoriam

Sorrow and adversity must come to associations as to individuals. In the death of our ex-president, F. W. Schmidt, we have sustained a collective loss as well as a personal one. He was one of that small far-sighted group which in the early winter of 1918 gathered in Chicago to form this association. He believed, as did those others, in the value of collective activity. He watched the early infant steps of the new-born association with tender care and solicitude, always modestly seeking to keep himself in the background, yet self-sacrificing to further our common cause. On the Board of Directors continually, on the Executive Committee for the last several years, and president for one term he faithfully sought to advance our interests, earnestly and simply doing all he could in the furthering of the Association that it might be of real value to the industry. He was quick to see the value in the establishment of a Bureau of Engineering, and his support in this undertaking, as in other matters, was prompt and generous. He never shirked a duty, nor regarded any task as requiring too great a sacrifice of time or effort. We have had no truer friend or one more loyal to our common interests.

Individually, too, we shall miss him, miss his genial, kindly presence and his warm and loyal friendship. Bravely he lived; bravely he died; and bravely has he fared forth into that land unknown and mysterious, and into which each of us in his turn shall enter. We shall miss him, of course; but our grief at his departure will be tempered by the belief that in another world and on a higher plane he is finding that opportunity for service for which our mortal lives should prepare us.

To his family we extend our deepest sympathy, with a realizing sense of their poignant grief. The inspiration which his sons will find in the life of their father comes to them as his last blessing and benediction.

* * * * * * *

Winter Storage of Stone

For some time it has seemed to us that the importance to crushed stone producers, contractors, and the state highway departments of arranging some plan whereby winter production of crushed stone might be carried on for storage on the job can hardly be over-emphasized. The crushed stone producers would unquestionably welcome a longer operating season; the contractors, by having stone in stock on the roadside, would be in less liklihood of running out of their aggregate requirements during the busiest part of the season, thereby avoiding considerable delay and expense in the prosecution of their work. It is certainly in the interests of the state higway departments to see that the contracts are expeditiously executed and to cooperate in such plans as would lead to that result. Manufacturers of equipment for both the quarry industry and that used by contractors would certainly wish to further any procedure which would tend to maintain a more uniform market for their products. It is recognized that tangible results in this line of endeavor may be more easily obtained in local areas without treating the question of winter storage of stone as a national issue; and further, that the state highway deparments have not found it feasible to make payment for materials delivered but not used. In some states special legislation would be required to enable the state highway departments to make payments for material in stock before it is actually used in construction.

The Associated General Contractors of America have shown an active interest in this problem, and with them we have had considerable correspondence on this subject. The Portland Cement Association has also evidenced its interest and desire to cooperate in leveling out the peak demands during the active construction season. The Department of Commerce has expressed itself forcefully in favoring such logical plans and procedure as might be mutually determined upon to more nearly level the peaks and valleys of construction and production, and has signified its willingness to assist us in evolving some workable plan. Our correspondence on this subject has been rather voluminous, as we have been impressed with the service that could be rendered not only our own industry, but also those construction interests associated therewith, if some feasible plan for winter production of stone, with subsequent storage on the job for future use, acceptable alike to crushed stone producers, contractors and state highway departments, could be determined upon.

It is therefore with a real sense of duty and obligation that your president has accepted an invitation very courteously extended by the Associated General Contractors of America to meet with their Executive Board in Kansas City on October 4th, 5th and 6th, and to open the discussion on this subject by a short address on October 5th at the session on Highway Problems.

We would welcome comment, suggestions, counsel and advice, specific or general, from those crushed stone producers who feel with us that the solution of this problem is worthy of serious consideration. Please do not hesitate to write promptly, giving the value of such thoughts as may occur to you.

Associate Members and Local Association Meetings

An associate member long active in our association affairs has inquired as to whether associate members would be permitted to attend the various local association meetings as they are held from time to time. He

states that he would be personally very glad to go out of his way to attend the different local association meetings, viewing it as a pleasant opportunity to meet the producers of the several territories in a social way and to enjoy with them the visits to the various producing plants which are frequently a part of the local association meeting programs.

It is doubtless true that associate members have refrained from attending the local association meetings from a sense of diffidence and hesitancy. We realize that in the National Association our contact with associate members has been to our mutual advantage in ways too numerous to discuss, well-known as they are to each of us. We have enjoyed the camaraderie of our contact with our manufacturing brethren, which has of itself been of value both to them and to us. We see no reason why the line should be drawn at local association meetings, and we assume they would be as welcome in attending local association meetings as they certainly are at our national conventions.

In order, however, to test the sense of the various local associations on this matter, we communicated with the Eastern Stone Association, Western Pennsylvania Stone Producers Association, Ohio Crushed Stone Association, New York State Crushed Stone Association, Mid-West Division of the N. C. S. A., and the Southwestern Division of the N. C. S. A. The response from each association has been prompt and cordial, indicating clearly that associate members are welcome to attend the meetings of the local associations. This is as it should be. In our Weekly Bulletin, as occasion demands, we will publish the dates and places of forthcoming local association meetings, and we herewith on behalf of these associations extend to all of our associate members a cordial and sincere invitation to attend any of the meetings, as they may desire. Our associate members have been individually and collectively helpful to us in their constructive criticism, advice and counsel, and we believe they will be equally so to the various local associations.

Detroit Convention

Detroit is the Mecca of the crushed stone industry for the week of January 17, 1927. There is every indication that the convention to be held in that city at the Book-Cadillac Hotel will be better arranged, more largely attended, and of greater value than any we have ever held. It is too early to write of our plans in detail; but it is not too early for each of us to set aside the first few days of this week as given over to attending the convention.

The Book-Cadillac Hotel is peculiarly well adapted for meeting our exacting requirements. The exposition of manufacturers' equipment, larger and more complete than ever before, will be held on the same floor as are our meetings and noonday luncheons. The entire ballroom floor of this hotel will be given over to our various activities. All crushed stone producers are cordially invited to attend whether or not members of the Association.

ALL STATES NOW AID IN HIGHWAY PROGRAM

For the first time the States now are giving 100 per cent cooperation in the Federal aid highway improvement work of the Bureau of Roads of the Department of Agriculture, Thomas H. MacDonald, chief of the bureau, announced August 21. Montana, the one State which had failed to take up its share of the obligations, he said, now joined in the participative work and is financing its part of the Federal aid program in its domain.

Mr. MacDonald said special effort is being made to coordinate roadway extension work under Federal aid with the railroads in the development of facilities for travel in regions more or less inaccessible to the public. Out in the Grand Canyon in Arizona, he pointed out, roadway facilities have been developed which permit bus travel from one railroad to the northern rim of the canyon, through Cedar Brakes and Rice's Canyon. That particular area heretofore has been inaccessible to the public except to automobilists driving their own cars.

Other Sections Opened Up

Similar cooperative work between the States and the Federal Government is reported as opening up hitherto generally inaccessible sections adjacent to the Yellowstone National Park, the Roosevelt Dam, Apache Trail and other sections.

"By these extensions," Mr. MacDonald said, "we are opening territory to the average man who cannot afford to have a car and driver, and make available to him, as an average American, the national scenic resources of the country. We are opening up, for instance, that region of the United States adjacent to Alberta, through which American travel can lead up through Glacier Park to the Canadian line.

"Following up the railroad through there you get a more or less standardized view of the country but with the roads now developing much scenic country is being opened to automobile travel, permitting the public to get away from the beaten paths into unspoiled nature. This work may be regarded as one of the by-products of the activities of the bureau.

Surveys in New England

"Our main work now is to build roads with the cooperation of the States in the populous sections of the country. Up in Vermont and New Hampshire, for example, we are today making transportation surveys to determine the flow of traffic through those States on interstate channels of travel. By these surveys which have been going on for the past fortnight, we will not only locate the flow of traffic but what types of roadway improvement are needed and where the first construction or reconstruction should be inaugurated to make available the best systems for the most traffic.

"The question we are continually confronted with is what might be called the emergency aspect—the determination of which particular channels of interstate roadway travel most need improvement out of the funds we have available for the year. We are trying to find the main stems of traffic and to furnish the greatest benefit to

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most people.

"Meantime the States also are working under their own funds, in addition to the cooperative aid activities.

Work of States Outlined

"The Federal aided roads are approximately one-half of what the States themselves are building with their own independent projects. During 1925, for instance, the Federal aid mileage completed—that is the roads completed by cooperative financing of the Federal and State governments, was 11,328 miles. The roads completed independently by the State highway departments during the same year reached a total of 23,164 miles.

"This means that the road construction by State and Federal cooperation was 49 per cent of the total mileage of roadway construction in the United States. The mileage of Federal-aid road construction during the year just ended, June 30, 1926, runs to a little higher figure than for 1925.

"Federal assistance is a very important factor in the East and West South Central States and the Mountain States where the Federal-aid roads constitute from two-thirds to three-quarters and more of the annual program of construction.

Results Are Discussed

"In the Middle Atlantic and East Central States, the percentage of roads built without Federal assistance is the highest. It is more than two-thirds of the annual program in each case in these latter States, whereas for the country as a whole the Federal-aid program is practically half of the annual construction program carried on under the State highway departments.

"While the Federal aid is shown by our figures of results to be in all States a considerable factor invaluable to some and helpful to others, the fact that in all groups of States from a fifth to two-thirds of the highways improved under the supervision of the State highway departments are built with State funds entirely without Federal participation indicates that the offer of Federal assistance has not had the effect of inducing the States to spend more money for highway improvement than they would otherwise have found expedient.

"Federal aid is going on along the main roads as reconstruction. The area of most congested population in the United States, with the exception of that area in the immediate vicinity of New York and New Jersey, is in Massachusetts, Connecticut and Rhode Island and in both those regions we are doing a great deal of work now in cooperation with the States."—U. S. Daily.

FATALITIES REPORTED SLIGHTLY REDUCED IN QUARRIES OF COUNTRY

A comparison of the number of accidents and fatalities to quarry workers in the United States in 1923 and 1924, shows that the rate for 1924 among 94,242 employes was 1.63 fatalities per thousand full-time or 300-day workers, as compared with 1.68 in 1923, according to an announcement made by the Bureau of Labor Statistics of the Department of Labor August 24. This is the lowest rate reported since 1911. The non-fatal injury rate during 1924, it was said, was 175.03, while in 1923 it was 176.04.

According to the announcement, the accidents to workers in this industry in 1924 resulted in 138 deaths and 14,777 injuries and in 1923 in 143 deaths and 14,990 injuries. There were 59,126 men employed inside the quarry pits, and of these 96 were killed and 8,990 injured, giving a fatality rate of 1.90 and an injury rate of 178 per 1,000 of 300-day workers; outside the quarries, it was learned, at crushers, mills, rock-dressing plants, etc., there were 35,116 employes, of whom 42 were killed and 5,787 injured, the fatality rate being 1.24 and the injury rate 170.61.

The slight reduction in the fatality rate in 1924, it was said, was the result of a reduction in the number of fatal accidents in quarries producing limestone, slate, or trap rock, all other classes of quarries showing increased rates, while lower non-fatal injury rates were shown for cement-rock quarries, the rates in other kinds of quarries being higher than in 1923.

Of the 14,915 accidents reported by the quarry industry, according to the department's announcement, 138, or 0.92 per cent, caused death; 13, or 0.09 per cent, resulted in permanent total disability; 457, or 3.06 per cent, in permanent partial disability; 2,708, or 18.16 per cent, caused temporary disability lasting more than 14 days, and 11,599, or 77.77 per cent, caused temporary disability exceeding the remainder of the day or shift but not exceeding 14 days.—U. S. Daily.

Local Association Activities

Ohio Crushed Stone Association

The regular monthly meeting of the Governing Board of the Ohio Crushed Stone Association was held in the offices of the Association in Columbus, on September 9th, 1926, with Mr. E. E. Evans, President, in the Chair.

Minutes of the July meeting were read and approved without correction.

Formal action on the application of the Amiesite Asphalt Company of Ohio was taken, it being moved by Mr. Brandon and seconded by Mr. Rarey that this company be admitted to membership. This motion was unanimously carried.

A resolution was offered by Mr. Sharp that the Ohio Crushed Stone Association should most heartily cooperate with the Industrial Commission of Ohio in the preparation of a Quarry Code in the interest of Safety and that the Secretary be instructed to notify all members requesting that one or more representatives of their company be present at a meeting called by the Department of Safety and Hygiene of the Industrial Commission. This meeting is to be held in Columbus, Ohio, September 24th, 1926. This resolution was seconded by Mr. Rarey and unanimously carried.

Following this was a general discussion in which all present participated relative to the policy of having one or more definite subjects for discussion at each meeting and that these subjects be chosen by the Secretary and sent to all members in advance of the meeting so that they will be able to prepare something constructive to offer at the next meeting on these particular subjects.

The object of this being to try to work out something which we can recommend to the Engineers of the State and Counties.

It was decided, without motion, that this policy will be followed in the future.

The meeting was adjourned on motion of Mr. Brandon, seconded by Mr. Sharp.

Respectfully submitted,
CARL L. VAN VOORHIS,
Chief Engineer.

Western Pennsylvania Stone Producers Association

The Western Pennsylvania Stone Producers Association held its regular monthly meeting at the offices of the Carbon Limestone Company, Youngstown, Ohio, on September 17th.

The minutes of the previous meeting were read and approved.

Notice of the death of Frederick Wilhelm Schmidt was received and read and upon motion of Mr. Andrews, seconded by Mr. McKee, the Secretary was instructed to draft a suitable resolution, sending copy to the family of Mr. Schmidt.

It was decided upon motion of Mr. Andrews, seconded by Mr. Reinhold that an attorney be employed to handle the Sand and Gravel case at Harrisburg and that the Committee confer with the officials of the Association for further instructions before taking any action.

There being no further business, the meeting adjourned.

Respectfully submitted,
J. C. KING, Secretary.

New York State Crushed Stone Association

Twenty-one crushed stone producers and guests turned out for the August meeting of our Association on Friday the 27th of the month.

Meeting first at the plant of the Gouverneur Limestone Company at 10 A. M. an hour or more was consumed in an inspection of both the mill and quarry. This company presided over by those two genial chaps, H. H. Hodgkin and G. W. Dodds, is but a few years old, and while the daily output is only about 200 tons, the layout of the operation and the very fine grade of product augur well for future development. A detailed write-up of the plant is carried in the September 18th issue of Rock Products so we will necessarily forego any further explanation other than to say that we all thoroughly enjoyed seeing this operation, and thank Messrs. Hodgkin and Dodds for their hospitality.

Leaving Gouverneur we then motored over to Alexandria Bay, about thirty miles distant by highway, where our North Country hosts had arranged an elaborate dinner at one of the famous "Bay" hotels. Needless to say this was shared by all present amid surroundings one is seldom privileged to enjoy.

Afterwards, we were treated to an exceptionally lengthy ride through the Thousand Islands as guests of our hosts. To those of us who had never viewed this "Beauty spot of America", the trip was a revelation indeed. On the return trip which lasted upwards of three hours, we docked at one of the islands upon which was constructed a two million dollar edifice known as "The Castle." Here, through the courtesy of Mr. Laidlaw, Manager for the owner, Mr. Nobles, we made a short tour of inspection followed by President Seitz's call for a short business meeting.

Minutes of the July meeting at Utica were read and approved by vote after which Mr. Seitz spoke briefly on the necessity of postponing all unnecessary business thru a scarcity of time.

A motion was then offered and duly seconded that the next meeting be held at LeRoy on October 1st. Carried.

Mr. Schaefer then moved a vote of thanks to Messrs. Johnson, Adams, Ormsby, Hodgkin and Dodds for their courtesy as hosts of the day. Seconded by Mr. Babcock and unanimously carried.

Mr. Johnson then offered a motion of thanks of the

Association to Mr. Laidlaw for his part in making the day so successful. Adopted unanimously after proper support.

Mr. Schaefer then urged full attendance at both the LeRoy meeting and also at the annual meeting in Albany in December, following which Editor Rockwood of "Rock Products", Chicago, was called upon to again tell us how he enjoyed being with us.

Then followed adjournment after which we returned to the mainland where the gathering dispersed at 5:30 P. M.

Respectfully submitted,
GEORGE E. SCHAEFER,
Secretary.

Active Members of the National Crushed Stone Association

A number of the members of the Association are contributing towards its financial support through two channels, first, by direct payment of dues into the national treasury, and, second, by payment of assessments to local associations towards the pledges of these local associations in support of the Bureau of Engineering. Also, some members have made individual contributions in addition to their regular membership dues.

In the past, in publishing the list of active members with the respective memberships held, no account has been taken of the sums paid into the national treasury through those channels. This procedure is manifestly unfair as the lists as previously published by no means truly reflect the total amounts contributed by the various members towards the financial support of the Association.

It was therefore deemed advisable by the Board of Directors at their recent meeting in Atlantic City, to translate the sums paid into the national treasury through local associations and by individual contributions, into terms of memberships in order that this list might more accurately reflect the support received from the various members.

The following list has been compiled on this basis and in cases where the number of memberships is larger than those previously listed it should be distinctly understood that this increase is not due to additional memberships having been taken out in the National Association but is merely a translation into terms of memberships of the sums paid in as mentioned above.

No Memberships	
2	Acme Limestone Co., Alderson, W. Va.
2	Albany Crushed Stone Co., 55 State St., Albany, N. Y.
1	Max A. Altgelt, New Braunfels, Texas.
3	American Crushed Rock Co., Ostrander, Ohio.
2	American Lime and Stone Co., Bellefonte, Pa.
1	American Stone Ballast Co., High Bridge, Ky.
9	Anna Stone Company, Anna, Ill.
2	Ashland Limestone Co., 408 Ashland National Bank Bldg., Ashland, Ky.
2	The Edward Balf Company, 14 Haynes St., Hartford, Conn.
1	Basalt Rock Co., Inc., Napa, Calif.
1	Beachville White Lime Co., Beachville, Ont., Canada.
3	C. C. Beam, Melvin, Ohio.
1	Belmont-Gurnee Stone Co., North Bergen, N. J.
55	Bessemer Limestone & Cement Co., 714 Stambaugh Bldg., Youngstown, Ohio.
1	O. H. Binns, Logansport, Ind.
2	Blake Brothers Co., 204 Balboa Bldg., San Francisco, Calif.
2	Blackwater Stone Co., 1016 Baltimore Ave., Kansas City, Mo.
2	Blue Ridge Stone Co., Roanoke, Va.
10	Bluffton-Lewisburg Stone Co., Findlay, Ohio.
2	Boggs, Burnam & Co., Richmond, Ky.
4	Bound Brook Crushed Stone Co., Bound Brook, N. J.
1	Britton Crushed Stone Corp., 717 Commerce Bldg., Rochester, N. Y.
1	Bromide Crushed Rock Co., Bromide, Okla.
30	Brownell Improvement Co., 1220 Chamber of Commerce Bldg., Chicago, Ill.
18	Buffalo Cement Co., 110 Franklin St., Buffalo, N. Y.
46	Buffalo Crushed Stone Co., 1048 Ellicott Square, Buffalo, N. Y.
16	Callanan Road Improvement Co., P. O. Box 773, Albany, N. Y.
2	Harry T. Campbell Sons Co., Inc., Towson, Md.
4	Canada Crushed Stone Corporation, Hamilton, Ont., Canada.
51	Carbon Limestone Co., 814 Stambaugh Bldg., Youngstown, Ohio.
1	Carolina Road Granite Co., 606 S. Michigan Ave., Chicago, Ill.
1	Carthage Crushed Limestone Co., P. O. Box 409, Carthage, Mo.
4	Casparis Stone Co., 302 Yuster Bldg., Columbus, Ohio.
9	The Casper Stolle Quarry & Contracting Co., 503 First National Bank Bldg., East St. Louis, Ill.
1	Cerulean Stone Co., Cerulean, Ky.
2	Chickamauga Quarry & Const. Co., 1st Nat'l Bank Bldg., Chattannoga, Tenn.
2	Chico Stone Products Co., 404 Santa Fe Bldg., Dallas, Texas.
1	Clayton Contracting Co., 3800 W. Pine Blvd., St. Louis, Mo.
1	The Collins Granite Co., Inc., R. F. D. No. 4, Danville, Va.
22	Columbia Quarry Co., 910 Century Bldg., St. Louis, Mo.
2	Commonwealth Quarry Co., Summit, N. J.
6	The F. E. Conley Stone Co., 253 Union Station, Utica, N. Y.
30	Connecticut Quarries Co., New Haven, Conn.
2	Consolidated Crushed Stone Corp., 1016 Baltimore Ave., Kansas City, Mo.
2	Consolidated Stone & Sand Co., Clare Road, Montclair Heights, Essex County, N. J.
27	Consumers Company, 111 W. Washington St., Chicago, Ill.
10	Cushing Stone Co., Inc., 437 State St., Schenectady, N. Y.
2	Daniel Contracting Co., 503 Market St., San Francisco, Calif.
2	Davis Bros. Stone Co., Lannon, Wis.
2	Delaware River Quarry & Construction Co., 21 Bridge St., Lambertville, N. J.
4	Dittlinger Lime Co., New Braunfels, Tex.
5	Dolese Bros. Co., 337 West Madison St., Chicago, Ill.
26	Dolese & Shepard, 108 South LaSalle St., Chicago, Ill.
10	Dolomite Products Co., 124 E. & B. Bldg., Rochester, N. Y.
1	Doolittle Limited, Hamilton, Ontario, Canada.
2	Duluth Crushed Stone Co., 1506 Alworth Bldg., Duluth, Minn.
20	John T. Dyer Quarry Co., Harrison Bldg., Philadelphia, Pa.
1	Dubuque Stone Products Co., Dubuque, Iowa.
5	East St. Louis Stone Co., 255 Arcade Bldg., East St. Louis, Ill.
16	Elmhurst-Chicago Stone Co., Elmhurst, Ill.
1	Eyermann Construction Co., 1210 S. Grand Blvd., St. Louis, Mo.
1	Fay Quarries, 101 Union St., New Bedford, Mass.

9 Federal Stone Co., 133 West Washington St., Chicago, Ill.
23 France Stone Co., 1800 2nd National Bank Bldg., Toledo, Ohio.
3 Franklin Limestone Co., 612 10th Ave. N., Nashville, Tenn.

72 General Crushed Stone Co., Drake Bldg., Easton, Pa.
2 Genessee Stone Products Co., Batavia, N. Y.
2 Gopher Stone Co., 1500 Johnson St., N. E., Minneapolis, Minn.
2 Gordon Crushed Stone Co., 18 Toronto St., Toronto, Canada.
4 Granite Rock Co., Box M, Watsonville, Calif.
2 Great Notch Corporation, 20 Washington Place, Newark, N. J.
2 Greenville Stone & Gravel Co., 269 Walnut St., Memphis, Tenn.
15 Grove City Limestone Co., Sharon, Pa.

2 Hagersville Contracting Co., Ltd., Hagersville, Ontario, Canada.
3 Hagersville Quarries, Ltd., 4 Flora St., St. Thomas, Ont., Canada.
1 Hardaway Contracting Co., Woodleaf, N. C.
2 Harris Granite Quarries Co., Salisbury, N. C.
4 Edward Hely Stone Co., Cape Girardeau, Mo.
1 Holston Quarry Co., Robbins Bldg., Box 292, Knoxville, Tenn.
2 T. C. Hubbert & Co., Inc., 707 S. Broome St., Wilmington, Del.
1 Hughes Stone Co., 808 Mayo Bldg., Tulsa, Okla.
1 Chas. O. Hunsicker, Hunsicker Bldg., Allentown, Pa.

4 Interstate Crushed Stone Co., P. O. Box 129, Springfield, N. J.

1 Jacksboro Stone Products Co., Jacksboro, Texas.
1 Johnson, E. B., Adams & Duford Co., Chaumont, N. Y.

10 Kelley Island Lime & Transport Co., 1125 Leader-News Bldg., Cleveland, Ohio.
3 Kentucky River Stone & Sand Co., Lawrenceburg, Ky.
2 Kentucky Rock Asphalt Co., Marion E. Taylor Bldg., Louisville, Ky.
2 Keystone Trappe Rock Co., Glenmore, Pa.
2 John T. Kilcourse, 70 Belknap St., Lawrence, Mass.
27 Kittanning Limestone Co., Safe Deposit Bldg., Kittanning, Pa.

3 Lake Erie Limestone Co., 901 Wick Bldg., Youngstown, Ohio.
2 Lake Shore Stone Co., 600 Canal St., Milwaukee, Wis.
2 Lambertville Stone Quarry Co., Colonial Trust Bldg., Philadelphia, Pa.
2 Landa Rock Products Co., New Braunfels, Tex.
24 John S. Lane & Son, Inc., Meriden, Conn.
2 Lawrence Stone & Gravel Co., 516 Commercial Bank Bldg., Raleigh, N. C.
24 Lehigh Stone Co., Kankakee, Ill.
27 LeRoy Lime & Crushed Stone Corp., LeRoy, N. Y.
2 Liberty Lime & Stone Co., Rocky Point, Va.
5 Ligonier Stone Products Co., Blairsville, Pa.
4 Linwood Cement Co., 714 Kahl Bldg., Davenport, Iowa.
5 L. & M. Stone Co., Mayro Bldg., Utica, N. Y.
5 Louisville Cement Co., 315 Guthrie St., Louisville, Ky.
1 Lutz Stone Company, Oshkosh, Wis.
17 Marble Cliff Quarries Co., 907 Hartman Bldg., Columbus, Ohio.

1 Mayville White Lime Co., Mayville, Wis.
5 Thos. McCroskey, Box 262, Knoxville, Tenn.
2 Joseph McCormick, 319 Taunton Ave., East Providence, R. I.
1 W. E. McNasser, Solvay Process Co., Syracuse, N. Y.
10 Mid-West Crushed Stone Co., 514 Traction Terminal Bldg., Indianapolis, Ind.
6 Mississippi Lime and Material Co., 201 W. 3rd St., Alton, Ill.
1 Molder Bros., 810 Wilson St., Findlay, Ohio.
5 Monon Crushed Stone Co., Box 366, Monon, Ind.
1 Montreal Crushed Stone Co., 590 Union Ave., Montreal, Canada.
4 Morris County Crushed Stone Co., 17 South St., Morristown, N. J.
1 T. A. Morrison & Co., Ltd., 1070 Bleury St., Montreal, Canada.

1 National Lime & Stone Co., Carey, Ohio.
1 National Quarries Co., Carey, Ohio.
10 National Stone Company, Box 832, Joliet, Ill.
42 New Castle Lime & Stone Co., 500 Greer Bldg., New Castle, Pa.
30 New Haven Trap Rock Co., 67 Church St., New Haven, Conn.
1 Northwestern Quarry Co., Rapid City, S. D.
2 Norton Stone & Lime Corp., Arkay Bldg., Albany, N. Y.

6 The Ohio Marble Co., Piqua, Ohio.
2 Old Colony Crushed Stone Co., Quincy, Mass.
15 A. C. O'Loughlin Co., 131 N. Homan Ave., Chicago, Ill.

6 Peerless Quarries, Inc., 404 Court St., Utica, N. Y.
2 Pembroke Limestone Corporation, Pembroke, Va.
1 A. Petrillo Co., 5 Edgemoore Road, Wilmington, Del.
4 Piedmont Corporation, Bona Allen Bldg., Atlanta, Ga.
2 Pounding Mill Quarry, Pounding Mill, Va.
1 Edmund Putnam, Box 852, Pittsfield, Mass.
2 Quartzite Quarries, Inc., Luverne, Minn.
2 Queenston Quarries, Ltd., St. Davids, Ontario, Canada.

2 Raleigh Granite Co., Raleigh, N. C.
1 Reinhold & Co., Inc., 1422 Oliver Bldg., Pittsburgh, Pa.
52 Rock-Cut Stone Co., 537 Union Bldg., Syracuse, N. Y.
2 Rock Hill Quarry & Const. Co., 1026 Title Guaranty Bldg., St. Louis, Mo.
1 Tayloe Rogers, Radford Limestone Corp., 1st Nat'l Bank Bldg., Roanoke, Va.
1 Rowe Contracting Co., Malden, Mass.

2 Saluda Crushed Stone Co., 214 Capers Bldg., Greenville, S. C.
1 J. D Sargent, Mt. Airy, N. C.
2 Schumacher Stone Co., Pandora, Ohio.
1 Skrainka Const. Co., 806 Security Bldg., 4th and Locust Sts., St. Louis, Mo.
2 Leatham D. Smith Stone Co., Sturgeon Bay, Wis.
1 Southern Mineral Co., 523 Gravier St., New Orleans, La.
1 Southern Crushed Stone & Granite Co., R.. F. D., Trenton, S. C.
2 Sowerbutt Quarries, Paterson, N. J.
1 Spartanburg Quarries Corp., 139½ E. Main St., Spartanburg, S. C.
2 Stringtown Crushed Rock Co., McAlester, Okla.
1 Thomas Sullivan, 1042 Omaha Nat'l Bank Bldg., Omaha, Nebr.
1 Sunlight Crushed Stone Co., Madisonville, Ky.
9 Superior Stone Co., 5 N. La Salle St., Chicago, Ill.
1 The Supply Distributors Corp., Marion Bldg., Cleveland, Ohio.
2 Susquehanna Stone Co., 1007 Franklin St. Williamsport, Pa.

1 The Tarbox-McCall Stone Co., 852 Weston Ave., Findlay, Ohio.
16 Templeton Limestone Co., Kittanning, Pa.
2 Texas Trap Rock Co., 610 Maverick Bldg., San Antonia, Tex.
1 Thomas & Frankenbery, Canon City, Colo.
2 Thurber Earthen Products Co., 1701 F. & M. Bank Bldg., P. O. Box 1868, Ft. Worth, Tex.

2 The Toledo Stone & Glass Sand Co., R. R., Sylvania, Ohio.
20 Tomkins Cove Stone Co., Tomkins Cove, N. Y.
22 Trap Rock Company, Minneapolis, Minn.
1 Jas. C. Travilla, Pilot Knob Ore Co., 211 N. 7th St., St. Louis, Mo.
5 R. B. Tyler Co., 114 Fourth St., Louisville, Ky.
2 Union Rock Co., 1403 East 16th St., Los Angeles, Calif.
2 Universal Granite Quarries Co., 133 W. Washington St., Chicago, Ill.
2 F. R. Upton, Inc., 821 Union Bldg., Newark, N. J.
2 Van Camp Stone Co., 12 E. 6th St., Cincinnati, Ohio.
1 Virginia Limestone Corp., 505 Mt. Trust Bldg., Roanoke, Va.
4 Wagner Quarries Co., Schmidt Bldg., Sandusky. Ohio.
2 Waterstreet Trap Rock Co., Water Street, Pa.
2 Waukesha Lime & Stone Co., Waukesha, Wis.
1 Welden Springs Quarry Co., Inc., Welden Springs, Mo.
1 Wentworth Quarries, Ltd., Vinemount, P. O., Ontario, Canada.
43 West Penn Cement Co., 2215 Oliver Bldg., Pittsburgh, Pa.
2 Western Lime & Cement Co., Milwaukee, Wis.
4 The Weston & Brooker Co., Columbia, S. C.
2 Whitehouse Stone Co., Spitzer Bldg., Toledo, Ohio.
2 Wickwire Spencer Steel Corp., Station B, Buffalo, N. Y.
2 Wing & Evans, 40 Rector St., New York, N. Y.
2 Winston & Co., Inc., Masonic Bldg., Harrisburg, Pa.
5 Wisconsin Granite Co., 105 W. Monroe St., Chicago, Ill.
1 Wood County Stone & Const. Co., Bowling Green, Ohio.
2 Woodville Lime Products Co., 622 Madison Ave., Toledo, Ohio.
2 John Wunder Co., Broadway and K Sts., Minneapolis, Minn.
2 York Hill Trap Rock Quarry Co., 98 State St., Meriden, Conn.

Associate Members of the National Crushed Stone Association

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Crushing Plants and Machinery.

American Manganese Steel Co., Chicago Heights, Ill.
"Amsco" Manganese Steel Castings.

American Tar Products Co., Union Trust Bldg., Pittsburgh, Pa.
Tar Products for Road Construction and Maintenance.

Armstrong Manufacturing Co., Waterloo, Iowa.
Blast Hole Drills, Bit Dressing Machines.

Atlas Powder Co., Wilmington, Del.
Explosives and Blasting Accessories.

Austin Mfg. Company, 400 N. Michigan Ave., Chicago, Ill.
Rock Crushing Machinery.

Earle C. Bacon, Inc., 26 Cortlandt St., New York City.
Complete Plants, Crushers, Elevators, Screens, Conveyors.

The Barrett Company, 40 Rector St., New York City.
Tarvia for Road Construction, Repair and Maintenance.

Blaw-Knox Co., P. O. Box 915, Pittsburgh, Pa.
Manufacturers of Steel Products.

The Browning Crane Co., 16226 Waterloo Rd. N. E., Cleveland, Ohio.
Locomotive Cranes.

C. G. Buchanan Co., Inc., 90 West St., New York City.
Crushers, Crushing Rolls, Magnetic Separators.

The Bucyrus Company, South Milwaukee, Wis.
Steam, Electric, "Diesel and Gas Shovel," Dredges.

Buffalo Wire Works, 521 Terrace, Buffalo, N. Y.
Wire Cloth and Screens.

Burrell Engineering & Construction Co., 513 West Jackson Blvd., Chicago, Ill.
Design and Construction.

Canadian Explosives, Limited, Canada Cement Bldg., Montreal, Can.
Explosives and Blasting Supplies.

Canadian Westinghouse, Ltd., Hamilton, Ontario, Canada.
Cranes, Motors, etc.

The Carroll Chain Co., 265 Hosack St., Columbus, Ohio.
"Carroll" Solid Weld Steam Shovel Hoisting Chains.

Cement Mill and Quarry, 542 Monadnock Block, Chicago, Ill.
"Publishers."

Cincinnati Rubber Mfg. Co., Cincinnati, Ohio.
Conveyor and Transmission Belting, Suction Hose, Dredging Sleeves.

The Columbus McKinnon Chain Co., 5th and Merrith Sts., Columbus, Ohio.
Hercules Solid Weld Steam Shovel Chain.

Denver Rock Drill Mfg. Co., 30 Church St., New York City.
Rock Drills and Mining Accessories.

The R. & J. Dick Co., Passaic, N. J.
"Dickbelt," for Transmission, Elevating and Conveying.

E. I. du Pont de Nemours & Co., Wilmington, Del.
"Explosives of All Kinds and Blasting Accessories."

Easton Car and Construction Co., Easton, Pa.
Quarry Cars.

Ensign-Bickford Co., Simsbury, Conn.
Safety Fuse and Cordeau Bickford Detonating Fuse.

Fairbanks, Morse & Co., 347 W. 4th St., Cincinnati, Ohio.
Diesel Engines, Electric Motors.

Fate-Root-Heath Co., Plymouth, Ohio.
"Plymouth" Gasoline Locomotives.

Flexible Steel Lacing Co., 4607 Lexington St., Chicago, Ill.
Alligator and Flexco H. D. Belt Fasteners.

Frog, Switch & Mfg. Co., Carlisle, Pa.
Manganese Steel Castings.

General Electric Co., Schenectady, N. Y.
Electrical Apparatus and Supplies.

Gill Rock Drill Co., Lebanon, Pa.
Blast Hole Drilling and Fishing Tools.

The Goodyear Tire and Rubber Co., Inc., Akron, Ohio.
Belting: Transmission, Conveyor, Elevator; Hose, Packing.

Graham Coal Co., Commercial Trust Bldg., Philadelphia, Pa.
Coal.

Grasselli Powder Co., Cleveland, Ohio.
Manufacturers of Explosives.

B. Greening Wire Co., Hamilton, Ontario, Canada.
Wire Rope.

Hadfield-Penfield Steel Co., Bucyrus, Ohio.
Manufacturer of Manganese Steel.

Harnishchfeger Corporation, 38th & National Aves., Milwaukee, Wis.
Electric Traveling Grab Bucket Cranes.

The Hayward Co., 50 Church St., New York City.
Hayward Orange Peel and Clam Shell Buckets.

The Hendrick Mfg. Co., Carbondale, Pa.
Perforated Metal Screens, Elevator Buckets.

Hercules Powder Co., Wilmington, Del.
Explosives and Blasting Supplies.

Ingersoll-Rand Company, 11 Broadway, New York City.
Rock Drills, Steel Sharpeners, Oil Furnaces and Hoists.

The Jeffrey Mfg. Co., Columbus, Ohio.
Elevating and Conveying Machinery.

Keystone Lubricating Co., Philadephia, Pa.
Lubricating Greases and Lubricating Devices.

Keystone Consolidated Publishing Co., 90 West St., New York City.

Koehring Company, Milwaukee, Wis.
Gasoline Shovels, Cranes and Draglines.

Koppel Industrial Car and Equipment Co., Koppel, Pa.
Industrial and Portable Railway Material Work.

The Loomis Machine Co., Tiffin, Ohio.
Blast Hole, Prospecting and Drilling Machinery and Tools.

The Lubriko Co., Meadow and Jackson Sts., Philadelphia, Pa.
"Lubriko Greases."

Manganese Steel Forge Co., Richmond St. and Erie Ave., Philadelphia, Pa.
"Rol-Man" Screens, Chains, Plates and Forged Products.

The Marion Steam Shovel Co., Marion, Ohio.
Power Shovels and Cranes—Steam, Gasoline and Electric.

Mid-West Locomotive Works, Cor. Spring Rd. and Alabama Ave., Cincinnati, Ohio.
Quarry Locomotives.

The Morgan Engineering Co., Alliance, Ohio.
Crushers, Overhead Traveling Cranes and Mill Machinery.

Mussens, Limited, Phillips Place Bldg., Montreal, Canada.
Rogers Timber Clamps, Mixers, Loaders.

New York Belting & Packing Co., 91 Chambers St., New York City.
Conveyors, Elevator and Transmission Belting.

Northern Explosives, Ltd., 623 Drummond Bldg., Montreal, Canada.
Blasting Supplies.

The Ohio Locomotive Crane Co., Bucyrus, Ohio.
"The Ohio Crane."

The Osgood Company, Marion, Ohio.
Power Shovels and Combinations.

Pit and Quarry, Rand McNally Bldg., Chicago, Ill.
"Publishers."

Quaker City Rubber Co., Wissinoming, Philadelphia, Pa.
Belting—Hose—Packing.

Rock Products, 542 So. Dearborn St., Chicago, Ill.
"Publishers."

Robins Conveying Belt Co., 15 Park Row, New York City.
Material Handling and Screening Equipment.

The Sanderson-Cyclone Drill Co., Orrville, Ohio.
Drills, Big Blast Hole, Drilling and Fishing Tools.

Shope Brick Co., East 8th and Division Sts., Portland, Oreg.
Concrete Brick.

The Orville Simpson Co., 1230 Knowlton St., Cincinnati, Ohio.
Screens, ROTEX, level, self-cleaning, 100 to ¼" mesh.

Smith Engineering Works, 32nd and Locust Sts., Milwaukee Wis.
Rock Crushers—Gyratory, jaw and reduction.

The Spencer Construction Co., Eastern Division—Macdonald Engineering Co., Garrett Building, Baltimore, Md.
Contracting Engineers.

Symons Bros. Co., Railway Exchange Bldg., Milwaukee, Wis.
Ore, Rock and Gravel Crushers.

The Traylor Engineering & Mfg. Co., Allentown, Pa.
Crushing, Cement and Mining Machinery.

S. G. Taylor Chain Co., 140 So. Dearborn St., Chicago, Ill.
Taylor Mesaba Steam Shovel Chains.

Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
TISCO Manganese Steel Castings.

The Thew Shovel Co., Lorain, Ohio.
Steam, Gasoline and Electric Shovels, Cranes, Draglines.

Trojan Powder Co., Allentown, Pa.
Explosives and Blasting Supplies.

Tredick Oil and Grease Co., Philadelphia, Pa.
Manufacturers of Petroleum Products.

Union Explosives Co., Clarksburg, W. Va.
Explosives and Blasting Supplies.

Vulcan Iron Works, Wilkes-Barre, Pa.
Steam, Gasoline, Electric Locomotives.

The W. S. Tyler Co., Cleveland, Ohio.
Woven Wire Screens and Screening Equipment.

George D. Whitcomb Co., Rochelle, Ill.
Gasoline Locomotives.

Williams Patent Crusher and Pulverizer Co., 813 Montgomery St., St. Louis, Mo.
Hammer Crushers.

G. H. Williams Co., Erie, Pa.
Cranes and Clam Shell Buckets.

EDITOR'S NOTE: *In connection with the above list we wish to call attention to the fact that several companies are contributing through local associations to the National Association although they are not members of the National Association and consequently are not listed. It is hoped that these companies will soon take out membership in the National Association and we can then properly acknowledge the support which they are so generously giving.*